# AIR FORCE HUMAN RESOURCES LABORATORY

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## RETENTION OF AIR FORCE ENLISTED PERSONNEL: AN EMPIRICAL EXAMINATION


Thomas R. Saving
Brice H. Stone

RRC, Incorporated
3833 Texas Avenue, Suite 256
Bryan, Texas 77801

Larry T. Looper
John N. Taylor

MANPOWER AND PERSONNEL DIVISION
Brooks Air Force Base, Texas 78235-5601



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AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235-5601

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WILLIAM E. ALLEY, Technical Director
Manpower and Personnel Division

NANCY GUINN VITOLA, Chief
Manpower and Personnel Division

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This paper documents a multiyear effort to quantify the relationship between the national labor economy and retention of experienced personnel in the Air Force. A general labor-theory model is presented to explain total force retention. The model is then extended to describe retention in specific career fields. Probit equations are developed to predict individual retention decisions across first, second, and career term retention decision points within each career field. The empirical results generally support hypotheses concerning direction and strength of impact of demographic, policy, bonus, and wage variables with considerable variation being noted across career fields. Future research issues are also proposed. Keywords include:


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Thomas R. Saving
Brice M. Stone

RRC, Incorporated
3833 Texas Avenue, Suite 256
Bryan, Texas 77801

Larry T. Looper
John N. Taylor

MANPOWER AND PERSONNEL DIVISION
Brooks Air Force Base, Texas 78235-5601

Reviewed and submitted for publication by

Robert C. Rue, Major, USAF
Chief, Manpower and Force Management Systems Branch
Manpower and Personnel Division

This publication is primarily a working paper.
It is published solely to document work performed.

Summary

This paper documents research to describe and quantitatively estimate the relationship between the national labor economy and the ability of the Air Force to retain qualified and experienced personnel to accomplish its defense mission. To provide a firm foundation for the subsequent empirical work, a generalized theoretical model is presented to explain total force retention. This model is then extended to describe retention behavior in individual career fields, and an equation is developed to estimate the retention decisions of individual airmen. To support the empirical portion of the research, a large-scale historical database containing personnel, institutional, and market data was developed. The empirical results generally support a priori hypotheses concerning the direction and strength of impact on retention of demographic, policy, and wage variables, although the employment variable exhibits some degree of instability. Several other variables show varying impacts across first, second, and career term decision points. Most notable among these are the positive tendency of females to reenlist in the first term versus their negative tendency to reenlist in the second and career terms and the positive effect of the length of active service on first term reenlistment. The effects of military and civilian compensation differed significantly across career fields and decision points. The effect of reenlistment bonus is consistently strong across the career fields and terms of enlistment. Generally, demographic factors become less important in the second and career term, although they are significant in the first term decision. The research concludes by suggesting several additional research issues. The results of this research should make a significant contribution to the information base which supports the retention and compensation policy decision process.

# PREFACE

The research documented in this technical paper was accomplished as part of Project 7719, Force Acquisition and Distribution Systems and Task 771920, Manpower and Personnel Models. The specific work unit, 77192011, is titled Estimation of Air Force Enlisted Manpower Supply. For several years the Air Force Human Resources Laboratory (AFHRL) has been conducting a research program to quantify the relationships between the national labor economy and the accession and retention of qualified Air Force enlisted personnel. The research presented in this paper is the culmination of a 2-year program focusing on retention through econometric modeling of the reenlistment decision. The ultimate goal is a more thorough understanding of the impact of wages and bonuses, force policies, and individual demographics on retention behavior resulting in more efficient use of Air Force compensation resources and a more experienced defense force.

Appreciation is expressed to Dr. Bill Alley and Major Bob Rue for their invaluable assistance and guidance during the AFHRL editing process. Their comments added strength and clarity to the presentation of the econometric model and the empirical results. For the corporate authors, appreciation is expressed to Jonathan Fast, Barbara Randall, and Jerry Hayman for their many hours of data preparation and computer programming, and to Paula Altieri and Karen Hunn for applying their word processing skills to prepare this final copy.

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# I. INTRODUCTION

The retention decisions of Air Force enlisted personnel have always been significantly affected by economic factors that are outside the direct control of the military system. Thus, military personnel planners must possess an in-depth understanding of the complex interactions among the enlisted force, military compensation policy, and the national labor economy. As enlisted personnel progress through their military careers, they gain maturity, training, and experience, which makes them excellent candidates for job opportunities outside the military. In order for the Air Force to retain a sufficient number of specialized and experienced enlisted personnel to accomplish its mission, a thorough understanding of the skilled labor market and its occupation-specific and experience-specific attributes is necessary.

This paper discusses a retention model and presents the results of applying the model to the enlisted force by occupational and experience groupings. Section II of the paper presents the retention model and the labor theory on which the subsequent empirical work is based. Section III outlines the development of the Historical Airman Data (HAD) Base used in the econometric work. Section IV presents the results of the detailed econometric analysis of retention by Air Force Specialties (AFSs) and experience groupings. The analysis also presents important differences between occupation and experience groupings with respect to civilian and military wage elasticities. Section V summarizes the major conclusions of the project and presents suggested avenues for future research.

## II. DEVELOPMENT OF ENLISTED RETENTION MODEL

The Air Force competes with private and public organizations for enlisted personnel in two distinct national labor markets: the entry level or unskilled market and the skilled market. To analyze Air Force accessions, the unskilled market is the relevant market. In the unskilled market, the Air Force competes with other employers, as well as with the post-high school education system (DeVany & Saving, 1982). Conversely, in analyzing retention, the skilled labor market is the relevant market. Skilled Air Force enlisted personnel possess occupation-specific knowledge which must be considered in the modeling of the retention decision process. The approach employed in the following retention analysis utilizes a model of retention that considers both the occupational (i.e., Air Force Specialty [AFS]) and individual characteristics as well as policy and force management factors.

### Experience Groups

For convenience, it is assumed that the Air Force consists of three length-of-service groups: Group 1 consists of airmen with lengths of service between 0 and 4 years, group 2 consists of airmen with lengths of service between 4 and 8 years, and group 3 consists of airmen with lengths of service greater than 8 years. The use of a three-group framework for the theoretical development simplifies the discussion and focuses attention on the important determinants of retention.

The supply of entrants into groups 2 and 3 ($S_2$ and $S_3$), which are the relevant groups for the retention analysis, is defined as the population of <u>eligible-to-reenlist</u> airmen at the end of their term of enlistment. Since reenlistment is not an available course of action for those airmen who are reenlistment ineligible, they cannot become new entrants to groups 2 and 3 and, thus, are not considered a part of the supply for groups 2 and 3.

The supply of potential reenlistees, $S_2$ and $S_3$, can be written as

$$\begin{aligned} S_2 &= S_2\,(Q_1,\ Q_2,\ m_2,\ m_3,\ c_2,\ c_3,\ F_1) \\ S_3 &= S_3\,(Q_1,\ Q_2,\ Q_3,\ m_3,\ c_3,\ F_1,\ F_2) \end{aligned} \tag{1}$$

where $Q_j$, $m_j$, $c_j$, and $F_j$ represent, respectively, the quality requirements ($Q_j$), the military compensation ($m_j$), the civilian wage ($c_j$), and the number of airmen ($F_j$) in groups 1, 2, and 3. Increases in the quality requirements of new accessions ($Q_1$) are assumed to increase the proportion of group 1 that is eligible to reenlist and, accordingly, increase supply to group 2 ($S_2$). On the other hand, an increase in group 2 or group 3 quality requirements ($Q_2$ or $Q_3$) is assumed to reduce the supply of entrants ($S_2$ and $S_3$) since fewer will meet the required quality. Increases in military compensation for groups 2 and 3 are assumed to increase the supply of entrants ($S_2$ and $S_3$), while increases in civilian wages ($c_2$ and $c_3$) are assumed to reduce the supply of entrants ($S_2$ and $S_3$).

The departures from the first group (excluding premature separations and ineligible-to-reenlist airmen) form the available enlisted pool for second group accessions. The Air Force, in determining its career and quality needs, affects the size of the available personnel pool by declaring certain individuals ineligible to reenlist. In order to maintain an equilibrium force level, the number of those reenlisting from the eligible-to-reenlist group 1 departures must be equal to the total departures from group 2, resulting from both reenlistments into group 3 and separations to civilian jobs. The eligible-to-reenlist departures from group 2, in turn, form the eligible-to-reenlist personnel pool for group 3 accessions. The number reenlisting from this group must equal the total departures from the third group.

The foregoing discussion illustrates an important aspect of the Air Force enlisted personnel system. Given force level and quality, the Air Force must set compensation in such a way that reenlistment goals can be met; i.e., equilibrium is attained at a desirable experience distribution. This relationship can best be understood by recognizing that quality requirements and military compensation are important factors in determining $S_2$ and $S_3$. If wages, either through direct pay or reenlistment bonuses, are not appropriately set, then either quality must adjust or the experience level of the force will change. For example, in the event that military compensation does not keep pace with relevant civilian job market wages, then quality and/or the experience level of the force must fall.

**Individual AFSs**

The Air Force is concerned not only with the quality and experience distribution of the total force but also with the manning levels of individual AFSs. The previous discussion can be extended to handle the manning of AFSs by disaggregating by AFS. In order to analyze a particular AFS, several assumptions must be made:

1. For each AFS, the Air Force has a desired level of authorizations to fill.

2. Across all AFSs, Air Force compensation is identical, and the individual AFSs cannot affect regular military compensation.

3. Within an AFS, airmen are homogeneous with respect to quality, though quality may vary across AFSs.

4. For AFSs experiencing shortages in certain experience groups, Air Force pays a reenlistment bonus which is assumed to vary inversely with the reenlistment rate.

Given these assumptions, equilibrium in the *ith* AFS requires that

$$R_i = R_i(m_i, B_i, c_i, Q_i, F_i) = L_i(m_i, B_i, c_i, Q_i, F_i) = L_i \qquad (2)$$

where $R_i$ represents the number of accessions into the ith AFS, $L_i$ represents the number of losses for the ith AFS, and $F_i$ represents the manning requirement for the ith AFS. (Note that the subscript, j, denoting experience level, has been dropped to simplify the discussion. It should be recognized, however, that the discussion can be viewed as relevant to a specific longevity group or to the force in general) For some AFSs, the Air Force is unable to fill personnel requirements at a desirable level of quality. In this situation a reenlistment bonus, $B_i$, may be offered to increase wages and encourage a larger number of eligibles to reenlist.

**Theoretical Model of Individual Retention**

To this point, the development of the enlisted retention model has emphasized the level of reenlistments required to maintain given personnel manning levels by AFS and by experience. The number of airmen actually reenlisting is composed of two components: the number of reenlistment-eligible airmen leaving a given experience group and the probability that a randomly chosen airman leaving that given group will reenlist. Mathematically,

$$R_{i,j+1} = P_{ij}S_{ij} \tag{3}$$

where $R_{i,j+1}$ represents the number of airmen reenlisting into group j+1 that are in AFS i and group j; $P_{ij}$ represents the probability that the representative eligible-to-reenlist airman in AFS i, completing a tour of duty in group j, will reenlist and enter group j+1; and $S_{ij}$ represents the number of eligible-to-reenlist departures from group j in AFS i per period. The probability of reenlistment, $P_{ij}$, depends on two sets of factors: the first set represents the individual airman's attitude toward an Air Force career versus a civilian career, as affected by individual-specific factors; and the second set represents job-specific aspects, such as pay and duty assignment.

In order to model the reenlistment decision, a function which represents an airman's attitude to reenlist is needed. In many ways, such a function is similar to other functional relationships which can be modeled as binary choices made by individuals; e.g., whether to buy a new car or house. These problems can be represented and solved through the construction of an attitude function in the following way.

Assume that a variable Z can be defined for each airman, such that Z is a linear function of specific factors affecting each airman's attitude toward the Air Force (e.g., age, marital status, race) and Air Force-specific components (e.g., pay) so that

$$Z = a + xb \tag{4}$$

where x is a row vector of individual-specific and Air Force-specific components, and b is a column vector of coefficients. Assume further that the higher the value of Z, the greater the likelihood that an individual airman will reenlist; i.e., the more positive is the airman's attitude toward reenlistment.

Assume that a critical value $Z^*$, for $Z$, is associated with each airman such that if the $Z$ of that airman is greater than $Z^*$, the airman reenlists, and if $Z$ is less than $Z^*$, the airman separates. Of course, not all airmen have the same attitude function so the critical value of $Z$, $Z^*$, will differ across airmen. Assume that the probability distribution (density function) across individuals of the critical values $Z^*$ is $f(Z^*)$. The integral of the density function indicates the proportion of airmen with critical values $Z^*$ in any given range $Z_1$ to $Z_2$. The probability, P, that a randomly chosen airman will reenlist given the component vector x is

$$P = \int_{-\infty}^{Z} f(Z^*)\, dZ^* = F(Z) = F(a + xb) \tag{5}$$

where $Z = a + xb$ is the airman's predicted Z value and $F(Z) = F(a+xb)$ is the cumulative distribution function associated with probability density function $f(Z^*)$.

The estimation of P for any given airman would be difficult because the continuous variable Z cannot be observed; that is, there is no information on the individual airman's attitude toward reenlisting. The only available information is whether that airman stayed in the Air Force or separated, and the individual-specific and Air Force-specific components of the vector x. Therefore, let R represent a binary variable which equals 1 if the individual airman reenlists and 0 otherwise. Since $F(Z)$ is the probability that a randomly chosen airman will reenlist given the component vector x, the probability that the representative airman separates, $P_S$, is given by

$$P_S = Pr(R = 0) = 1 - F(Z). \tag{6}$$

The econometric model for estimating this binary decision is the probit model which assumes that Z is a normally distributed random variable (Amemiya, 1981; Pindyck & Rubinfeld, 1981). Thus, the probability that an airman will reenlist, given the airman's vector of attributes, x, can be deduced from the standard cumulative normal distribution, $N(a+xb)$. The value P can be interpreted as the probability that an airman will stay in the Air Force, given the airman's vector of attributes x. The signs of the estimated coefficients will indicate the direction of change in the probability of staying; i.e., the qualitative relationships between reenlistment and one of the independent variables, such as military compensation. If the coefficient has a negative value, the independent variable is inversely related to reenlistment. Conversely, a positive coefficient, implies a direct relationship between reenlistment and the independent variable.

**Estimation Equation: Specification of the Retention Model**

In order to estimate the parameters of the probit model, a maximum-likelihood estimation procedure is employed. To construct the likelihood function for a set of separations and reenlistments, it is assumed that each airman's decision is independent. If P is the probability of reenlistment and (1 - P) is the probability of separation, then the probability of a given set of decisions (e.g., separation, separation, reenlistment, reenlistment, reenlistment, separation), occurring is the product of the probabilities of each decision; i.e.,

$$(1 - P)(1 - P)(P)(P)(P)(1 - P). \tag{7}$$

Since P = N(Z), the cumulative normal evaluated at Z, and (1 - P) = [1 - N(Z)], (7) can be written as

$$L^* = \prod_{k=1}^{n} N(Z_k)^{R_k}[1 - N(Z_k)]^{1 - R_k} \tag{8}$$

where $L^*$ is the likelihood function, n is the number of individuals in the sample, and $R_k$ is equal to 1 if the individual reenlists and to 0 if the individual separates. The $Z_k$ values are equal to the estimates from the following equation estimated initially using ordinary least squares,

$$\begin{aligned} Z_k = a + b_1ACED_k + b_2RACE_k + b_3AFQT_k + b_4SEX_k + b_5MARST_k \\ + b_6DEPT_k + b_7RMC_k + b_8BONUS_k \\ + b_9RIND_k + b_{10}REMP_k + b_{11}CWAGE_k \end{aligned} \tag{9}$$

The maximum-likelihood technique then uses the estimated coefficients in (9) as a base and iterates until the likelihood of the given set of separations and reenlistments is maximized.

The variables used in equation (9) describe the military and civilian environment for each airman at the time of the reenlistment/separation decision. A brief description of the variables is provided in Table 1. The first six explanatory variables in the table are binary variables describing the characteristics or attributes of the individual airman. The continuous

## Table 1. Variable Descriptions

| | | |
|---|---|---|
| ACED – | Academic Education Level | |
| | 1 | high school graduation (diploma) or beyond (some college etc.), excluding GED or Certificates |
| | 0 | otherwise |
| RACE[a] – | Race | |
| | 1 | non-Caucasians, |
| | 0 | Caucasians |
| AFQT – | Armed Forces Qualification Test Mental Categories | |
| | 1 | mental categories Is and IIs |
| | 0 | otherwise |
| DEPT – | Dependents | |
| | 1 | two or more dependents |
| | 0 | otherwise |
| SEX – | Sex | |
| | 1 | females |
| | 0 | males |
| MARST – | Marital Status | |
| | 1 | single |
| | 0 | otherwise |
| RMC – | Real Regular Military Compensation | |
| | The present value of a 4-year income stream from military service in real dollars (1967 base year) | |

[a] For career analysis, 1 refers to Black only, 0 indicates Caucasian and other.

Table 1. (Concluded)

| | | |
|---|---|---|
| REMP - | Employment Rate | |
| | First Term: | Employment rate for 20-to 24-year-old population. |
| | Second Term and Career: | Employment rate for 25-to 34-year-old population. |
| RIND - | Selective Service Induction Rate (at time of entry) | |
| | Number of Selective Service inductees divided by the total 18- to 21-year-old male population. | |
| TAFMS - | Total Active Federal Military Service (in years). | |
| BONUS - | Real Selective Reenlistment Bonus | |
| | Real bonus dollars (base year 1967) | |
| CWAGE - | Real Civilian Wage | |
| | The present value of a 4-year income stream in real dollars (base year 1967) | |

monetary variables, RMC, BONUS, and CWAGE, are adjusted for inflation using the consumer price index. REMP, the employment rate, describes the general economic environment confronting the airman at the time the decision is made. RIND controls for draft pressure at the date of entry; e.g., draft-induced enlistees.

Once the coefficients of equation (9) are estimated, a predicted value can be generated for $Z_k$. The predicted value of $Z_k$ forms the upper limit in the cumulative normal distribution $N(Z_k)$ and is used to evaluate $F(Z_k) = N(Z_k)$, which is equal to P, the probability of reenlistment. The probability of reenlisting can be interpreted for each AFS as a reenlistment rate, defined as the ratio of the number of reenlistments to the number of eligible-to-reenlist airmen making a decision. The evaluation of $N(Z_k)$ is used to estimate the elasticities for each independent variable with respect to the probability of reenlisting. The elasticity is interpreted as the percentage change in the reenlistment rate due to a one percent change in the independent variable. Each elasticity is computed using the values of the other explanatory variables at their sample means.

Before the retention model was tested, several a priori hypotheses concerning the expected relationships between explanatory variables and reenlistment were offered. If ACED and AFQT are quality indicators, and if high quality personnel have higher opportunity costs of remaining in the military than do lower quality personnel, negative reenlistment relationships may be expected for ACED and AFQT. If job opportunities are relatively scarce for females and non-Caucasians, then positive reenlistment relationships would be expected for SEX and RACE. The military offers monetary and non-monetary benefits for married couples with dependents, suggesting a positive reenlistment relationship for DEPT and a negative relationship for MARST.

Reenlistments are expected to be positively related to RMC and BONUS, while negatively related to REMP and CWAGE. The selective service induction rate, RIND, is the induction rate that confronted each airman at the time the airman entered the military. Thus, RIND is a measure of the effect of draft-induced enlistees on reenlistment, and therefore, a negative relationship is expected. The effect of the draft should be primarily exhibited in the initial reenlistment/separation decision and, thus, will not appear beyond the first term analysis.

## III. DATA DEVELOPMENT

The data utilized for the retention analysis of Air Force enlisted personnel was obtained through the construction of a longitudinal data base from historical data maintained at the Air Force Human Resources Laboratory (AFHRL) and augmented with military compensation and policy data. This information source is called the Historical Airman Data (HAD) Base and covers a time period from 1956 to the present. The HAD Base provided two primary types of data for the retention analysis:

1. **Enlisted personnel data**
   - **Retention data**
   - **Airman demographic data**

2. **Market and institutional data**

The HAD Base contains data on more than 2.5 million airmen who entered the Air Force between 1956 and the present and includes the relevant economic and policy data for the time period. Although the HAD Base provides almost 28 years of data, the retention analysis used reenlistment/separation decision data from January 1974 to March 1982.

### Defining the Experience and AFS Populations

The retention analysis was performed at the five-digit AFS level of disaggregation for three categories of enlistment: first term, second term, and career. First term included airmen in their first term of enlistment, including both 4-year and 6-year enlistees. Second term included airmen in their second term of enlistment, regardless of years obligated. Career airmen were defined as all airmen beyond a second term of enlistment but with less than 20 years of service. The Air Force defines career airmen as all airmen beyond a second term of enlistment. The definition of career used in the analysis was necessary to avoid confounding the retirement alternative with other civilian opportunities. Thus, the analysis was performed on a population of airmen with less than 20 years active duty. The number of five-digit career fields analyzed differed for each term of enlistment due to a decline in the number of observations from first term to second term. The career group tended to exhibit slightly higher numbers of observations than did the second term group due to the greater number of separation/reenlistment decisions which can be made by airmen during a career term.

### Retention Data

Information from the HAD Base's retention data formed the basis for the criteria to determine the AFS and category of enlistment (first term, second term, or career) to which each airman belonged. Over 230 five-digit AFSs exist in the Air Force, and the Air Force Specialty Codes (AFSC) representing each of the AFSs have changed over the 1974 to 1982 time period. At the time an airman performs a personnel action, referred to as a transaction

(e.g., reenlistment, separation, or extension), the control AFS (CAFS) for that airman is recorded. The CAFS at the time of the transaction was used to determine the AFS population to which the airman was assigned. The chronological sequence of transactions was the primary means of identifying first term, second term, and career transactions. Total active military service (TAFMS) was the factor providing the means for separating prior-to-20-years career transactions from post-20-year career transactions.

### Airman Demographic Data

The information on demographic data was recoded to the form described in Table 1. In the case of ACED and RACE, recoding was necessary to insure consistency over the time period analyzed. For example, race was redefined for the career term analysis due to an Air Force change in the definition which initially combined Caucasians with others (non-Caucasians and non-Blacks). The change in the definition of RACE was made sufficiently early, so as not to affect the first term and second term analyses. Academic education was also recoded due to changes in the definitions of the codes over the 1974 to 1982 time period. Information about an airman's marital status and dependent status at or near the time that a transaction was initiated affected the airman's opportunity cost of leaving the service. The dependent status was also used in the computation of the airman's military compensation package at the time of the reenlistment/separation decision.

### Market and Institutional Data

The Market and Institutional data from the HAD Base provided the following information:

1. Employment data by age and sex
2. Industry wages by Standard Industrial Classification
3. Military compensation data on basic pay, basic allowance for quarters (BAQ), basic allowance for subsistence (BAS), and reenlistment bonuses
4. Selective Service induction rates
5. Consumer Price Index (CPI)

Retention data recorded on separation date and date of entry provided the criteria for selecting the appropriate information for each airman to determine RMC, BONUS, CWAGE, REMP, RIND, and TAFMS.

### RMC and BONUS

The information collected at the time the airman performed the transaction formed the basis for the computation of the airman's military compensation and selective reenlistment bonus. RMC and BONUS were based on a projected 4-year horizon, discounted to present value terms (a 10 percent personal discount rate was applied), and deflated by the CPI. Thus RMC and BONUS were expressed in real dollars (1967 base year). RMC was a composite

of four factors: (a) Basic pay, which accounts for grade and length of service, (b) BAQ, which accounts for grade and dependent status, (c) BAS, which is basically the same for all enlisted airmen, and (d) the marginal tax advantage accruing from the nontaxable form of BAQ and BAS. The marginal tax advantage was based on annual military income (Basic pay + BAQ + BAS) and the marginal tax rate for the year in which the reenlistment/separation decision was made. Variable promotion rates, when relevant, as well as changes in basic pay due to longevity, were included in the 4-year projection. BAQ is dependent on grade and number of dependents of the airman. A marginal tax rate was determined for annual income levels based on standard federal income tax tables.

Reenlistment bonuses are dependent on basic pay, which, in turn, depends on grade and longevity, and on the bonus multiple applied to the particular AFS for a given time period. When relevant, save pay (a reenlistment bonus paid in the absence of a selective reenlistment bonus) was computed for airmen possessing a date of enlistment prior to June 1974. Depending on the date of the reenlistment decision, airmen received their bonuses in either lump sum or yearly installment payments. A present value computation of the airman's reenlistment bonus was calculated if the bonus was received through an installment method of payment. Reenlistment bonus was the product of three factors: (a) the basic pay at the time of reenlistment/separation decision, (b) the obligated years of the reenlistment term (generally 4 to 6 years), and (c) the bonus multiple assigned to the AFS (values of 0 to 4).

**CWAGE**

Since the retention analyses were performed by AFS, an effort was made to determine a civilian wage from an occupation similar to the AFS of the airman making the reenlistment/separation decision. The primary source of civilian wage data was the Bureau of Labor Statistics (BLS) which provided industry wage data for several hundred Standard Industrial Classification industries. The selection of the industry for each AFS often resulted in several options.

The determination of the appropriate industry was a multistage process utilizing Air Force Regulation (AFR) 39-1 (Department of the Air Force, 1984) which defines the occupation in the Air Force, BLS Industry-Occupational (I-O) Matrix (U.S. Department of Labor, 1982) which maps occupation into industries and vice versa, Dictionary of Occupational Titles (DOT) (U.S. Department of Labor, 1977) which defines occupation and industries, and the Department of Defense (DoD) Occupational Conversion Manual (Department of Defense, 1980) which defines DoD occupations in terms of DOT occupations. The first step required the definition of the occupation in which the airman's AFS would be categorized. AFR 39-1 provides information concerning the duties and responsibilities of the AFS, as well as the DoD occupational category. The information from AFR 39-1, in conjunction with the DOT, was used to define an occupational category (categories) for each AFS. The category (categories) for each AFS were matched with the I-O Matrix to determine which industries primarily include the occupation. The category or industry with the highest

occurrence of the occupation was selected to provide the civilian wage for the analysis. When possible, the most specific industry wage was used for the analysis. The civilian wage was expressed as a discounted (10 percent discount rate) present value over a 4-year horizon, adjusted by the CPI at the time of the reenlistment/separation decision. Thus, CWAGE was expressed in real (1967 base year) dollars.

**Employment Rate, Selective Service Induction Rate, and TAFMS**

REMP is a variable which was differentiated by the sex and approximate age of the airman. The first term analysis used employment rates for male/female age groups of 20 to 24 years of age. Second term and career used employment rates for male/female age groups of 25 to 34 years of age. REMP represents the proportion of the male/female, 20- to 24/25- to 34-year-old civilian noninstitutionalized population which is employed.

The Selective Service induction rate was based on the airman's date of entry, the date on which the airman signed an obligation to enter the military. Thus, the rate of Selective Service induction confronting the airman on his date of entry was the value chosen to represent the draft pressure which may or may not have influenced the airman's decision to enter the Air Force. RIND is the ratio of the number of Selective Service inductees to the 18- to 21-year-old male population.

TAFMS is a continuous variable expressed in integer years. TAFMS was recorded at the time of the airman's reenlistment/separation decision. TAFMS accounts for the total active duty service of the airman.

## IV. EMPIRICAL RESULTS

Section II contains the development of a testable model of the retention of enlisted personnel. The end result of this model development was equation (9). Two modifications were necessary to estimate this equation: (a) TAFMS was inserted in equation (9) for all categories of enlistment, and (b) the career term equation was estimated with and without the demographic factors (ACED, RACE, SEX, and AFQT). The reasons for these modifications are discussed in the following paragraphs.

The theoretical discussion in Section II assumed that all airmen in a specific length-of-service group made reenlistment decisions at the same time. In fact, airmen making decisions within a given category of enlistment have differing lengths of service. For a given category of enlistment, the effect of TAFMS might be expected to be direct since it reflects pay, rank, and retirement values. This hypothesis was true for second term and career but did not hold in the first term. First term airmen who reenlist tended to do so prior to the expiration date of their term of service (ETS). Airmen who made a decision near their ETS tended to separate. Not surprisingly then, reenlistment became inversely related to TAFMS for the first term, given that the airman served at least 36 months of service.

RMC includes changes in basic pay due to longevity, and thus, the estimated effect of RMC was biased downward in the first term due to the tendency of reenlistments to occur at 3 to 4 years active duty, versus separations which occur at 4 years or more. Including TAFMS in the estimation equation removed the longevity bias of first term decision-making and resulted in an unbiased estimate of the coefficient of RMC. In the second term and career equations, the use of TAFMS minimized the bias in the RMC coefficient due to the pull of retirement.

The heterogeneity in the demographic factors (ACED, RACE, SEX, and AFQT) lessened as an airman progressed from first term to second term to career. At the career level, for example, the enlisted population was dominated by high school graduates and males. Only a few career AFSs had sufficient numbers of females to permit any analysis. For several AFSs, demographic factors that were important in determining first term and second term reenlistment; e.g., ACED, AFQT, SEX, had been filtered to a degree that their inclusion in the equation for career resulted in nonconvergence of the maximum likelihood estimator. Essentially, as an experienced group of airmen progressed through successive terms of enlistment, the group became more homogeneous with respect to such demographic factors as academic education, sex, and mental category. Since a variable must exhibit variation to have any statistical effect, those variables that become more alike (across airmen) lose their significance for the career level of the AFS.

### First Term Results

The first term results are summarized in Table 2. The table indicates for each explanatory factor the number of AFSs in which the estimated

Table 2. First Term Summary

| | Number Positive | Number Significant[a] | %[b] | Number Negative | Number Significant[a] | %[b] |
|---|---|---|---|---|---|---|
| ACED | 15 | 1 | 0.9 | 102 | 48 | 41.0 |
| RACE | 116 | 113 | 96.6 | 1 | 0 | 0.0 |
| AFQT | 11 | 2 | 1.7 | 106 | 58 | 49.6 |
| DEPT | 117 | 106 | 90.6 | 0 | 0 | 0.0 |
| MARST | 1 | 0 | 0.0 | 116 | 101 | 86.3 |
| SEX[c] | 82 | 49 | 45.4 | 26 | 3 | 2.8 |
| BONUS[d] | 81 | 65 | 75.6 | 5 | 1 | 1.2 |
| RMC | 114 | 83 | 70.9 | 3 | 0 | 0.0 |
| TAFMS | 0 | 0 | 0.0 | 117 | 113 | 96.6 |
| RIND | 12 | 2 | 1.7 | 105 | 78 | 66.7 |
| CWAGE | 4 | 1 | 0.9 | 113 | 94 | 80.3 |
| REMP | 40 | 15 | 12.8 | 77 | 39 | 33.3 |

[a] Statistically significant at the 90 percent level of confidence

[b] 117 AFSs had sufficient observations for analysis; percent of 117 AFSs which are significant.

[c] Only 108 AFSs had sufficient number of females for analysis.

[d] Only 86 AFSs had bonuses (SRB).

coefficient effect was positive or negative and also indicates the number of these estimated coefficients that were statistically significant. The estimated effects on reenlistment of the explanatory variables ACED, AFQT, MARST, TAFMS, RIND, and CWAGE were generally inverse while RACE, DEPT, SEX, BONUS, and RMC were generally direct.

REMP was a notable exception to the general rule that the results fit the a priori hypotheses. The estimated effect of REMP exhibited a significant degree of instability. The expected effect of REMP should be inverse since better civilian employment opportunities should reduce the probability to reenlist among first termers. The estimated effect of REMP was inverse in 77 AFSs; however, the estimated effect was direct in 40 AFSs. This finding seems to suggest that increased civilian employment opportunities actually increase reenlistments in certain AFSs. This unexpected variance from a priori expectations was mitigated somewhat by the fact that only 12.8 percent of the direct effects were significant, while 33.3 percent of the inverse effects were statistically significant. Although the primary impact of REMP was as expected, the relatively large deviation from the hypothesized norm does require an explanation. The intervening impact of two factors, bonuses and retraining, are offered as explanations. The precise reason for these impacts and the instability for REMP are discussed later in this paper.

The predominantly inverse and statistically significant effect of ACED and AFQT on the probability of reenlistment indicated the high opportunity cost of remaining in the military for high school graduates and above, and AFQT mental categories I and II. The estimated effect of RACE on reenlistment in first term was direct in over 99 percent of the AFSs and the estimated effect of SEX was direct in over 75 percent of the AFSs with females. The propensity for reenlistment by females in the first term may be caused by several factors, such as insufficient job opportunities for females, relative to their military career options, or enhanced promotion opportunities for females in the military as compared to the civilian sector.

The effects of the family status variables MARST and DEPT suggest that those individuals with family responsibilities are more likely to reenlist as evidenced by the estimated inverse effect for MARST and direct effect for DEPT. In over 99 percent of equations, the estimated effect of the family status variables was consistent with this interpretation. This overwhelmingly consistent estimated effect of the marital status and dependent variables is to be expected. The military offers married couples with dependents pecuniary and non-pecuniary advantages relative to the private/public sectors. For instance, BAQ is higher for airmen with dependents. In addition, base amenities such as childcare and commissary benefits increase in value with increases in the number of dependents.

The TAFMS variable strongly showed the expected inverse relationship in the first term, where in each of the 117 AFSs, the probability of reenlistment was inversely related to TAFMS. As indicated above, this inverse effect is the result of the fact that most airman who reenlist do so before the 48-month point. Thus, as reenlistments increase, the average TAFMS for first term decision makers will decline.

RMC and BONUS exhibited the expected direct relationship to reenlistment while CWAGE was predominantly inversely related (over 96 percent of the AFSs). The impact of RIND was inverse (over 89 percent of the AFSs), though only the early part of the time period analyzed was affected. An analysis of the relationship between the magnitude of the RMC and BONUS effects is discussed later.

As with the coefficient results just presented, elasticities for each AFS equation are too cumbersome to discuss individually; consequently, for each term, elasticity findings will be summarized and highlighted. (Results for two sample AFSs are presented in a later section). The elasticity of a variable, the percentage change in the reenlistment rate for a one percent change in the variable, is useful for determining the sensitivity of the reenlistment rate to changes in the variable. Across the 117 first term AFSs, the elasticity of RMC averaged 4.490 in the first term while ranging from a low of 0.888 for AFSC 511x0 to a high of 10.733 for AFSC 30?x1 (based on 83 positive, statistically significant coefficient values for RMC). This 4.5 elasticity indicates that a one percent increase in the RMC variable increases the probability of reenlistment by 4.5 percent. The variance of the elasticity of RMC across AFSs was 3.697. CWAGE had an average elasticity of -6.20 with a variance of 10.97 (based on 94 negative, statistically significant coefficient values) indicating that a one percent increase in CWAGE reduces the probability of reenlistment by 6.2 percent.

**Second Term Results**

In the second term, the demographic variables tended to play statistically weaker roles in the explanation of reenlistment, as well as exhibiting some reversals from the direction of their predicted effects. Table 3 presents a summary of the second term results. The demographic variables having the largest proportion of statistically significant coefficients were ACED, RACE, and DEPT with a direct impact on reenlistment and AFQT, MARST, and SEX with an inverse relationship. The estimated effect for both ACED and SEX were reversed in sign from their first term estimated effects. BONUS, RMC, and CWAGE provided the same relationships as their first term counterparts (direct, direct, and inverse, respectively). REMP displayed slightly more instability in the second term than in the first term with over 16 percent of the AFSs showing a direct and statistically significant relationship. The estimated effect of TAFMS completely reversed itself from an inverse first term effect to a direct and statistically significant effect in over 83 percent of the second term AFSs. For each explanatory variable, the proportion of the AFSs with statistically significant estimated effects which agreed with a priori predictions of directional impact declined from the first term results.

ACED was statistically significant in about 16 percent of the AFSs and exhibited a positive relationship in each statistically significant AFS. Non-high school graduates overcome their competitive disadvantage in the private sector through military work experience and additional technical training and schooling. The reversal of the sign on the SEX coefficient may be the result of a change in job opportunities due to the experience and training

## Table 3. Second Term Summary

| | Number Positive | Number Significant[a] | %[b] | Number Negative | Number Significant[a] | %[b] |
|---|---|---|---|---|---|---|
| ACED | 27 | 6 | 16.2 | 10 | 0 | 0.0 |
| RACE | 36 | 30 | 81.1 | 1 | 0 | 0.0 |
| AFQT | 13 | 1 | 2.7 | 24 | 10 | 27.0 |
| DEPT | 36 | 23 | 62.2 | 1 | 0 | 0.0 |
| MARST | 6 | 3 | 8.1 | 31 | 22 | 59.5 |
| SEX[c] | 1 | 0 | 0.0 | 9 | 7 | 70.0 |
| BONUS[d] | 16 | 10 | 62.5 | 0 | 0 | 0.0 |
| RMC | 33 | 21 | 56.8 | 4 | 0 | 0.0 |
| TAFMS | 35 | 31 | 83.8 | 2 | 0 | 0.0 |
| CWAGE | 6 | 1 | 2.7 | 31 | 20 | 54.1 |
| CEMP | 21 | 6 | 16.2 | 16 | 4 | 10.8 |

[a] Statistically significant at the 90 percent level of confidence.

[b] 37 AFSs with sufficient observations for analysis; percent of 37 AFSs which are significant.

[c] Only 10 AFSs had sufficient numbers of females for analysis.

[d] Only 16 AFSs had bonuses (SRB).

in the military or to the additional family pressures because of a larger proportion of females with marital intentions, spouses, and/or children. The estimated effect of TAFMS was positive in the second term, indicating the importance of longevity in the decision to reenlist/separate.

In the second term, the average elasticity of RMC was 1.483 with a variance of 0.799 (based on 21 positive, statistically significant coefficient values). The RMC elasticity varied from a low of 0.319 for AFSC 645x0 to a high of 4.644 for AFSC 305x4. The average elasticity for CWAGE was -1.70 with a variance of 1.38 (based on 20 negative, statistically significant coefficient values). Both the elasticity of RMC and CWAGE in the second term were markedly smaller than in the first term indicating a decreased sensitivity of reenlistments to the wage variables.

**Career Results**

In the career term, as indicated by Tables 4 and 5, the proportion of AFSs in which each of the demographic variables were statistically significant declined from the second term proportion. The direction of effect for the demographic variables in the career term equations (reported in Table 4) coincided with those estimated for the second term. BONUS, RMC, and TAFMS exhibited the highest proportion of statistically significant relationships and all were direct. The proportion of statistically significant CWAGE effects with an estimated inverse relationship was comparable to the second term proportion, approximately 53 percent (Table 4). ACED, RACE, AFQT, and SEX were then excluded in the estimated equations due to the homogeneity displayed by career airmen for these characteristics. With these four demographic variables removed, the estimation technique converged to a solution for five additional AFSs. Table 5 presents the results of these 39 abbreviated equations. The proportion of the estimated effects that were statistically significant in Table 5, as compared to Table 4 results, decreased for DEPT, MARST, REMP and RMC; increased for TAFMS and CWAGE and remained constant for BONUS. In the full equation, the TAFMS effect was direct in 100 percent of the AFSs and statistically significant in over 97 percent of the AFSs (33 of 34). The impact on reenlistment of the opportunity to retire at 20 years length of service was a predominant factor in the career term, as reflected by the importance of TAFMS and the high reenlistment rates.

The career term exhibited the lowest average elasticity for RMC (full model), 0.728, with a variance of 0.011, indicating a lower level of dispersion among the career fields (based on 29 positive, statistically significant coefficient values). AFSC 291x0 had the smallest elasticity, 0.069, with AFSC 306x0 providing the highest, 0.467. The low elasticities for RMC in the career term can be attributed to the reduction in the importance of RMC versus retirement. The mean value for the reenlistment rate averaged 94 percent over the 29 AFSs with positive and statistically significant relationships for RMC (variance for the reenlistment rate was 3.18), ranging from a low of 90 percent to a high of 97 percent. Few career-term people separate from the force prior to 20 years of service. Thus, the impact of RMC, though important, was not large. Bonuses are small in the career term and are used infrequently among the AFSs, but when present, the BONUS variable was statistically significant in five of the seven AFSs (Tables 4 and 5).

Table 4. Career Summary: Full Equation

| | Number Positive | Number Significant[a] | %[b] | Number Negative | Number Significant[a] | %[b] |
|---|---|---|---|---|---|---|
| ACED | 22 | 5 | 14.7 | 12 | 0 | 0.0 |
| RACE | 32 | 16 | 47.1 | 2 | 0 | 0.0 |
| AFQT | 11 | 0 | 0.0 | 23 | 5 | 14.7 |
| DEPT | 24 | 6 | 17.6 | 10 | 0 | 0.0 |
| MARST | 8 | 1 | 2.9 | 26 | 8 | 23.5 |
| SEX[c] | 3 | 0 | 0.0 | 8 | 3 | 27.3 |
| BONUS[d] | 6 | 5 | 71.4 | 1 | 0 | 0.0 |
| RMC | 34 | 29 | 85.3 | 0 | 0 | 0.0 |
| TAFMS | 34 | 33 | 97.1 | 0 | 0 | 0.0 |
| CWAGE | 5 | 0 | 0.0 | 29 | 18 | 52.9 |
| REMP | 18 | 0 | 0.0 | 16 | 3 | 8.8 |

[a] Statistically signficant at the 90 percent level of confidence.

[b] 34 AFSs used to analyze full equation in career; percent of 34 AFSs which are signficant.

[c] Only 11 AFSs had sufficient number of females for analysis.

[d] Only 7 AFSs had bonuses (SRB).

Table 5. Career Summary: Abbreviated Equation

| | Number Positive | Number Significant[a] | %[b] | Number Negative | Number Significant[a] | %[b] |
|---|---|---|---|---|---|---|
| DEPT | 26 | 5 | 12.8 | 13 | 1 | 2.6 |
| MARST | 8 | 1 | 2.6 | 31 | 8 | 20.5 |
| BONUS[c] | 7 | 5 | 71.4 | 0 | 0 | 0.0 |
| RMC | 39 | 32 | 82.1 | 0 | 0 | 0.0 |
| TAFMS | 39 | 39 | 100.0 | 0 | 0 | 0.0 |
| CWAGE | 2 | 0 | 0.0 | 37 | 22 | 56.4 |
| REMP | 22 | 1 | 2.6 | 17 | 3 | 7.7 |

[a] Statistically significant at the 90 percent level of confidence.

[b] 39 AFSs had sufficient observations for analysis; percent of 39 AFSs which are significant.

[c] Only 7 AFSs had bonuses (SRB).

**Sample AFS Results**

One aspect of the empirical results which requires more formalized examination is the difference in the elasticities of explanatory variables across AFSs and across categories of enlistment. While it is not practical to present results for all the individual Air Force specialities, Tables 6 and 7 display an example of first term findings for AFSCs 272x0 and 305x4. These represent, respectively, Air Traffic Control Operators and Electronics, Computers, and Switching Systems Specialists and illustrate the differences that exist among the various specialities. The elasticity of REMP for 272x0 is -13.706 while only -5.450 for 305x4. Other variables with considerable differences in elasticities were TAFMS, RMC, BONUS, DEPT, and MARST. The t values for the coefficients of the two career fields are statistically significant at the 90 percent level of confidence, with the exception of RIND for 305x4.

Two variables, RMC and BONUS, are of particular interest to policy makers. As previously stated, elasticities of both of these variables differed considerably across AFSs indicating that people in different AFSs reacted differently to pay and bonus changes. Tables 8 and 9 give further evidence of these differences. First term BONUS elasticity exhibited a standard deviation across AFSs of 50 percent the size of its average versus over 60 percent in the second term. RMC reflected a similar pattern, though the standard deviations as a percent of the average tended to be smaller, approximately 42 percent for the first term and 39 percent for the second term.

**Empirical Results Requiring Further Study**

An unexpected aspect of the empirical results was the difference between the effects of reenlistment bonus (BONUS) and regular military compensation (RMC). Since both represent pay, their elasticities might be expected to be the same. Tables 8 and 9 which provide some statistics from the first and second term analysis indicate, however, that the average ratio of the elasticity of RMC to the elasticity of BONUS across AFSs is 15.3 in the first term and 21.8 in the second term, instead of the expected 1.0.

Elasticities are used to compare the different effects of several independent variables on the dependent variable. For purposes of assessing the value of dollars in BONUS or RMC, the elasticities are not useful unless the mean values of the variables are comparable. Unfortunately, the mean values for RMC and BONUS are so radically different, 1.07 and 0.36 for BONUS (first term and second term, respectively) versus 18.52 and 20.68 for RMC, that the differences in the elasticities reflect the differences in the mean values more than differences in the effects of a dollar increase on reenlistment. Because of the disparity in the mean values, the marginal effects of RMC versus BONUS will be a better indicator of the relative merits of bonus pay versus regular military compensation in affecting reenlistments. In fact, for the first term, the average ratio of the marginal effect of RMC to that of BONUS across the 40 statistically significant AFSs of Table 8 was 0.84, although, in the second term, the average ratio across the 7 statistically significant AFSs of Table 9 did decrease to 0.27.

## Table 6. First Term: AFSC 272x0

| Variable Name | Elasticity[a] | Sample Mean | t Statistics |
|---|---|---|---|
| ACED | −0.398 | 0.939 | −6.140 |
| RACE | 0.072 | 0.139 | 10.600 |
| AFQT | −0.144 | 0.562 | −7.721 |
| DEPT | 0.083 | 0.238 | 8.017 |
| MARST | −0.152 | 0.447 | −7.427 |
| SEX | .014 | 0.082 | 2.982 |
| BONUS | 0.268 | 2.877 | 4.206 |
| EMC | 1.961 | 18.636 | 4.700 |
| TAFMS | −0.851 | 4.000 | −10.306 |
| RIND | −0.036 | 0.044 | −3.231 |
| CWAGE | −3.201 | 25.271 | −5.616 |
| REMP | −13.706 | 0.932 | −7.417 |

Number of Observations = 4916

Reenlistment Rate = 47 Percent (2346)

Percent Successful Prediction = 67 Percent (3337)

[a] Elasticities: percentage change in reenlistment rate for one percent change in the variable.

## Table 7. First Term: AFSC 305x4

| Variable Name | Elasticity[a] | Sample Mean | t Statistics |
|---|---|---|---|
| CONSTANT | 4.956 | 1.000 | 2.824 |
| ACED | -0.320 | 0.932 | -2.929 |
| RACE | 0.045 | 0.072 | 5.404 |
| AFQT | -0.186 | 0.831 | -2.766 |
| DEPT | 0.036 | 0.260 | 1.788 |
| MARST | -0.218 | 0.436 | -5.098 |
| SEX | 0.014 | 0.066 | 1.748 |
| BONUS | 0.357 | 1.460 | 6.800 |
| RMC | 4.228 | 18.595 | 4.448 |
| TAFMS | -0.402 | 3.984 | -2.285 |
| RIND | -0.011 | 0.048 | -0.455 |
| CWAGE | -3.588 | 13.854 | -2.821 |
| REMP | -5.450 | 0.886 | -3.412 |

Number of Observations = 2561

Reenlistment Rate = 33 Percent (853)

Percent Successful Prediction = 72 Percent (1864)

[a] Elasticities: percentage change in reenlistment rate for one percent change in the variable.

Table 8. Summary Statistics for BONUS and RMC: First Term[a]

| Variable | Mean | Standard Deviation |
|---|---|---|
| Elasticities:[b] | | |
| BONUS | 0.3374 | 0.1702 |
| RMC | 4.3459 | 1.8318 |
| Ratio (RMC/BONUS) | 15.2785 | 9.1868 |
| Marginal Effects:[c] | | |
| BONUS | 0.1141 | 0.0576 |
| RMC | 0.0739 | 0.0301 |
| Ratio (RMC/BONUS) | 0.8373 | 0.5275 |
| Mean Values:[d] | | |
| BONUS | 1.0761 | 0.5151 |
| RMC | 18.5247 | 0.1404 |
| Ratio (RMC/BONUS) | 20.4669 | 8.0373 |

[a] All summary statistics are based on 40 AFSs, where both BONUS and RMC were statistically significant (90 percent level of confidence).

[b] Elasticities: percentage change in reenlistment rate for one percent change in the variable.

[c] Marginal Effect: unit change in the reenlistment rate for a unit change in the variable.

[d] Mean Values: sample mean of the variable across all observations in the AFS.

Table 9. Summary Statistics for BONUS and RMC: Second Term[a]

| Variable | Mean | Standard Deviation |
|---|---|---|
| Elasticities:[b] | | |
| BONUS | 0.0799 | 0.0508 |
| RMC | 1.2201 | 0.4792 |
| Ratio (RMC/BONUS) | 21.8139 | 16.6438 |
| Marginal Effects:[c] | | |
| BONUS | 0.1780 | 0.0651 |
| RMC | 0.0407 | 0.0157 |
| Ratio (RMC/BONUS) | 0.2718 | 0.1571 |
| Mean Values:[d] | | |
| BONUS | 0.3604 | 0.3160 |
| RMC | 20.6771 | 0.1996 |
| Ratio (RMC/BONUS) | 82.2042 | 35.4921 |

[a] All summary statistics are based on 7 AFSs, where both BONUS and RMC were statistically significant (90 percent level of confidence).

[b] Elasticities: percentage change in reenlistment rate for one percent change in the variable.

[c] Marginal Effect: unit change in the reenlistment rate for a unit change in the variable.

[d] Mean Values: sample mean of the variable across all observations in the AFS.

The difference between the effects of RMC and BONUS could be due to many causes, including using a personal discount rate (10 percent) which overstates the perceived value to the airman of bonuses which were normally received as lump sums as opposed to RMC which was received over the life of the enlistment term. A second reason could be the existence of additional factors that are not included in the model (e.g., other demographic factors, assignment location, job satisfaction). These results, although partially explained, provide a fertile area for additional research.

Another unexpected empirical result which was briefly introduced in the earlier section on first term results is the relationship between REMP and reenlistment. The reenlistment rate would be expected to go down when employment is up due to the availability of civilian jobs; conversely, it would be expected to go up when employment is down. However, the relationship is confounded by the effect of bonuses and retraining. The Air Force may use bonuses to mitigate the draw of civilian employment. Also, personnel may retrain into a high employment career field hoping for future bonuses and enhanced post-military earnings. Several linear regressions of REMP and percentage of airmen retraining into an AFS on BONUS were run, and these confirmed the expected strong relationship between BONUS and REMP, as well as between REMP and the measure of retraining. Airmen facing reenlistment may not be viewing the current employment rate but rather may be considering a projected REMP at the time of separation, since airmen generally cannot separate prior to the expiration of their term of enlistment; they may only extend or reenlist. Investigation of the exact nature of these interrelationships is beyond the scope of this study.

**Goodness of Fit**

Some additional insight into the robustness of the economic results can be obtained by analyzing the accuracy of the econometric model. As shown in Table 10, the model estimated retention rates across the 117 first term AFSs within 1.28 percentage points of the actual mean values. Second term results across 37 AFSs were within 0.81 percentage points. Career term estimates for both the full and abbreviated equations averaged about 3 to 4 percentage points greater than the actual mean rates. This difference may be explained by noting the lack of variation in career reenlistment and the fact that actual reenlistment rates for the career term were above 90 percent (Amemiya, 1981). Both these factors tended to cause the estimation equations to predict very close to 100 percent career reenlistment and thus the mean values across the AFSs were larger than the actual rates.

Two additional statistics often used to evaluate an estimated binary choice model are a chi-square statistic resulting from the analysis of a contingency table and the likelihood ratio (Theil, 1971). The chi-square statistic is used to test the null hypothesis that the model does no better than a baseline prediction of actual reenlistment decisions versus an alternate hypothesis that the two models are different. (See the Appendix for a sample calculation.) All estimation equations or models were different from the baseline model at a 90 percent level of confidence. The mean and standard deviation of the chi-square values for each term of enlistment are presented in Table 10.

**Table 10. Accuracy of Econometric Model**

| | Retention Rates | Predicted Retention Rates | Chi-Square Statistic[g] | Likelihood Ratio |
|---|---|---|---|---|
| First Term[a] | 36.17[e] (9.26)[f] | 34.89 (10.99) | 382.15 (454.31) | 430.72[h] (521.55) |
| Second Term[b] | 73.70 (5.32) | 72.89 (7.28) | 248.90 (313.41) | 183.37[i] (228.00) |
| Career Term (Full Model)[c] | 95.34 (1.39) | 98.27 (0.78) | 90.06 (75.66) | 164.04[i] (160.34) |
| (Abbreviated Model)[d] | 95.22 (1.44) | 98.15 (0.82) | 82.45 (72.78) | 142.82[j] (142.25) |

[a] Based on 117 AFSs

[b] Based on 37 AFSs

[c] Based on 34 AFSs

[d] Based on 39 AFSs

[e] Mean Value

[f] Standard Deviation

[g] Chi-square critical value at the 90 percent level of significance is 2.71

[h] Chi-square critical value at the 90 percent level of significance is 18.55

[i] Chi-square critical value at the 90 percent level of significance is 17.28

[j] Chi-square critical value at the 90 percent level of significance is 12.02

The likelihood ratio also is chi-square distributed and indicates how well the estimated probit equation fits the data. The likelihood ratio was statistically significant at the 90 percent level for all estimating equations for all three categories of enlistment.

## V. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The empirical results support several qualitative and quantitative conclusions and raise some new questions that are beyond the scope of this paper. The research effort performed produced a set of empirical results concerning reenlistment decisions among first term, second term, and career (with less than 20 years active duty) airmen. In general, the qualitative results produced few surprises, with three possible exceptions: a) females were more likely than males to reenlist in the first term and less likely to reenlist in the second term and career, b) the TAFMS variable was inversely related to the probability of reenlistment in the first term because of an operational peculiarity of first term reenlistments, and c) the estimated employment relationship was not consistently negative; possibly due to the effects of reenlistment bonus and retraining programs.

In general, the signs of the estimated effects of the explanatory variables matched the a priori hypotheses of Section II. The robustness of the estimated equations is indicated by the consistent significance of the estimated coefficients through first term, second term, and career. This is especially true for reenlistment bonus, military compensation, TAFMS, and civilian wages, where most of the relationships were statistically significant with the expected sign. The demographic factors fared well, but varied in importance across categories of enlistment. Race was the most consistent statistically significant demographic factor through all three categories of enlistments, with dependents and marital status following closely.

The quantitative results indicate that there are differences between AFSs and experience groups. Though not directly tested, it was observed that the effects on reenlistment of military and civilian compensation differ substantially across AFSs and across categories of enlistment.

These findings suggest two operational uses. By employing a marginal analysis approach, it was noted that the impact of bonuses on reenlistment across AFSs and categories of enlistment was greater than that of RMC. This result implies that bonuses, not across-the-board pay raises, should be used to achieve reenlistment in critical AFSs. The second operational implication is that targeting of bonuses to specific AFSs at the three decision points is an effective use of limited financial resources to improve the experience level of the force.

Several avenues for future research are suggested from the analytical results:

1. Investigate the relationships between employment and retraining, as well as employment and reenlistment bonus for each category of enlistment.

2. Relate reenlistment to retention, which includes the ineligible-to-reenlist population.

3. Relate reenlistment to length-of-service continuation rates, e.g., the proportion of each length-of-service group which advances to the next length-of-service group.

4. Investigate other factors which may affect retention: demographic, duty-related, and location-oriented.

5. Determine the qualitative and quantitative differences caused by aggregating five-digit AFSs to the three-digit level, or higher, especially with respect to the reenlistment bonus.

6. Formally test for the differences in variable effects across AFSs and across categories of enlistment.

7. Examine the difference between the effect of regular military compensation and reenlistment bonuses.

These recommendations are viewed as the most significant questions to be addressed in subsequent study.

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## APPENDIX: Example Models for Chi-Square Statistic

One method for evaluating the effectiveness of an equation or model predicting retention decisions is to compare the model with a baseline that assumes the actual retention rate can be predicted but also assumes that an individual's decision is independent of the baseline model's prediction. A chi-square statistic is used to test the null hypothesis that the model does no better than the baseline versus an alternate hypothesis that the two models are different.

For example, consider the data in Table A-1. The reenlistment equation (model) correctly predicts 520 of 700 reenlistment decisions and 220 of 300 separation decisions for an overall 74 percent accuracy. For the baseline model, a 70 percent reenlistment rate is used but predictions are assumed to be independent of actual decisions. Table A-2 gives the results of the baseline model.

**Table A-1. Retention Equation Example Results**

| | | Predicted Decisions: Reenlist | Predicted Decisions: Separate | |
|---|---|---|---|---|
| Actual Decisions | Reenlist | 520 | 180 | 700 |
| | Separate | 80 | 220 | 300 |
| | | 600 | 400 | |

**Table A-2. Baseline Model Results**

| | | Predicted Decisions: Reenlist | Predicted Decisions: Separate | |
|---|---|---|---|---|
| Actual Decisions | Reenlist | 490 | 210 | 700 |
| | Separate | 210 | 90 | 300 |
| | | 700 | 300 | |

The baseline model correctly predicts 490 of 700 reenlistment decisions and 90 of 300 separation decisions for a 58 percent accuracy. The chi-square statistic for this example is 274.4 compared with a critical value of 2.7 for $\alpha = .10$ and one degree of freedom. The null hypothesis is rejected thus leading to the conclusion that the retention equation's prediction is different from the baseline or "chance" model. An examination of the individual cells leads to the further conclusion that the retention model performs better than the baseline since it predicts more actual reenlist/separate decisions than does the baseline model. Table A-3 further illustrates the accuracy of the prediction equations developed in the report by giving the mean and standard deviation of the percentage of successful predictions for each term together with the mean and standard deviation of the successful baseline predictions for each term.

**Table A-3. Prediction of Retention Decisions**

| | Percentage of Successful Predictions | Percentage of Successful Predictions for Baseline |
|---|---|---|
| First Term[a] | 72.98[e] (3.41)[f] | 55.24 (3.73) |
| Second Term[b] | 71.31 (7.97) | 59.88 (6.11) |
| Career Term (Full Model)[c] | 94.64 (1.39) | 91.15 (2.53) |
| (Abbreviated Model)[d] | 94.74 (1.37) | 91.01 (2.61) |

[a] Based on 117 AFSs

[b] Based on 37 AFSs

[c] Based on 34 AFSs

[d] Based on 39 AFSs

[e] Mean Value

[f] Standard Deviation

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